

WHAT IS CLAIMED IS:

1. An electron beam apparatus comprising a hermetic container which includes an electron source having electron emission devices and targets exposed to the electrons emitted from said electron source and further comprising a first member within said hermetic container,

wherein the value of the incident angle multiplication coefficient of secondary electron emission coefficient m_0 , which is a parameter of the following formula:

$$\frac{\delta_{\theta}}{\delta_0} = \frac{1 - \left\{ 1 - \frac{m_0 \cos \theta}{1 + (m_1)^{-1} \times (m_0 \cos \theta)^{m_2}} \right\} \exp(-m_0 \cos \theta)}{1 - \left\{ 1 - \frac{m_0}{1 + (m_1)^{-1} \times m_0^{m_2}} \right\} \exp(-m_0)} \times \frac{1}{\cos \theta}$$

General Formula (1)

is 10 or less,

when obtaining it from the value of secondary electron emission coefficient measured under the conditions that incident energy is 1 keV and incident angle is 0 degree as well as the values measured under the conditions that incident energy is 1 keV and incident angles θ are 20, 40, 60 and 80 degrees by conducting a regression analysis by the least square method in said general

formula (1),

provided that the second electron emission
coefficient of the surface of said first member has two
incident energies which satisfy the second electron
5 emission coefficient $\delta = 1$ under the vertical incident
conditions, and that when the larger energy of the
above two energies satisfying $\delta = 1$ is referred to as a
second cross-point energy, the secondary electron
emission coefficients for the primary electrons whose
10 incident angles are θ and 0 degrees are represented by
 δ_θ , δ_0 , respectively, and
 m_1 , m_2 have the values
 $m_1 = 0.68273$
 $m_2 = 0.86212$, respectively,
15 in the incident energy equal to or lower than the
second cross-point energy.

2. The electron beam apparatus according to claim
1, wherein the incident angle multiplication
20 coefficient of secondary electron emission coefficient
 m_θ on the surface of said first member is 5 or less in
the incident energy equal to or lower than said second
cross point energy when obtaining it from the value of
secondary electron emission coefficient measured under
25 the conditions that incident energy is 1 keV and
incident angle is 0 degree as well as the values
measured under the conditions that incident energy is 1

keV and incident angles θ are 20, 40, 60 and 80 degrees by conducting a regression analysis by the least square method in said general formula (1).

5 3. The electron beam apparatus according to claim 1 or claim 2, wherein said first member is provided with an uneven geometry at least on a part of its surface.

10 4. The electron beam apparatus according to claim 1, wherein said first member comprises a substrate provided with an uneven geometry at least on a part of its surface and a film coating said uneven geometry portion, the thickness of said film being smaller than
15 the height difference between the top and lowest portions of the uneven geometry of said substrate.

 5. The electron beam apparatus according to claim 1, wherein said first member is provided with an uneven
20 geometry at least on a part of its surface, said uneven geometry being formed in such a direction that the incident angle dependency of said secondary electron emission coefficient is reduced for any of the orbits of the electron beam from the above electron source as
25 well as of the electron beam reflected on said target side.

6. The electron beam apparatus according to claim 1, wherein said first member is provided with an uneven geometry at least on a part of its surface, said uneven geometry being formed in all directions parallel to the surface of said first member.

7. The electron beam apparatus according to claim 1, wherein said first member is provided with an uneven geometry at least on a part of its surface, said uneven geometry having the average cycle of 100 μm or shorter.

8. The electron beam apparatus according to claim 1, wherein said first member is provided with an uneven geometry at least on a part of its surface, said uneven geometry having the average cycle of 10 μm or shorter.

9. The electron beam apparatus according to claim 1, wherein said first member is provided with an uneven geometry at least on a part of its surface, said uneven geometry having the average roughness ranging from 0.1 μm to 100 μm .

10. The electron beam apparatus according to claim 1, wherein said first member is provided with an uneven geometry at least on a part of its surface, said uneven geometry consisting of the cycles periods of at least two kinds of unevenness.

11. The electron beam apparatus according to claim 1, wherein said first member is provided with an uneven geometry at least on a part of its surface, said uneven geometry being obtained by removing the material surface of said first member nonuniformly.

12. The electron beam apparatus according to claim 1, wherein said first member is provided with a film at least on a part of its surface, said film having a sheet resistivity of $10^7 [\Omega/\square]$ to $10^{14} [\Omega/\square]$.

13. The electron beam apparatus according to claim 1, wherein said first member is provided with a film at least on a part of its surface, said film containing at least one kind of metal, carbon, silicon, or germanium and consisting of nitride, oxide or carbide.

14. The electron beam apparatus according to claim 1, wherein said first member is provided with a film at least on a part of its surface, said film, when being formed on a smooth substrate so as to have a smooth surface, having a composition which provides secondary electron emission coefficient of 3.5 or less measured under vertical incident conditions.

15. The electron beam apparatus according to

claim 1, wherein said first member is provided with a film at least on a part of its surface, the surface of said film having a high oxygen concentration as compared with the inside thereof.

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16. The electron beam apparatus according to claim 1, wherein said first member is provided with a film at least on a part of its surface, said film being formed by any one of the following methods: sputtering,
10 vacuum deposition, wet printing, spraying, or dipping.

17. The electron beam apparatus according to claim 1, wherein said first member abuts said electron source, said first member having a first film provided
15 at least on a part of its surface and a conductive film provided on the portion where said first member and said electron source abut with each other, said first film and said conductive film being in contact with each other.

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18. The electron beam apparatus according to claim 1, wherein said first member abuts an electrode provided within said hermetic container for controlling the electrons emitted from said electron source, said
25 first member having a first film provided at least on a part of its surface and a low resistive film provided on the portion where said first member and said

electrode abut with each other, said first film and said low resistive film being in contact with each other.

5 19. The electron beam apparatus according to claim 1, wherein said first member is a spacer.

20. The electron beam apparatus according to claim 1, further comprising an electrode for
10 controlling the electrons emitted from said electron source.

21. The electron beam apparatus according to claim 20, wherein the voltage applied between the
15 electron emission device contained in said electron source and said electrode is 3 kV or higher.,

22. The electron beam apparatus according to claim 20 or claim 21, wherein said first member is
20 provided with a film at least on a part of its surface, said film being electrically connected to both of said electron source and said electrode.

23. The electron beam apparatus according to claim 1, wherein said electron source includes cold
25 cathode devices as an electron emission device.

24. The electron beam apparatus according to claim 1, wherein said target produces images when being exposed to electrons.

5 25. The electron beam apparatus according to claim 1, wherein said target is provided with a fluorescent substance.

10 26. An electron beam apparatus comprising a hermetic container which includes an electron source having electron emission devices and targets exposed to the electrons emitted from said electron source and further comprising a first member within said hermetic container,

15 wherein said first member has a film on its surface, the foundation of said film having an uneven geometry, the thickness of said film being smaller than the height difference between the top and lowest portions of the uneven geometry of said foundation.

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27. A spacer, wherein the value of the incident angle multiplication coefficient of secondary electron emission coefficient m , which is a parameter of the following formula:

$$\frac{\delta_{\theta}}{\delta_0} = \frac{1 - \left\{ 1 - \frac{m_0 \cos \theta}{1 + (m_1)^{-1} \times (m_0 \cos \theta)^{m_2}} \right\} \exp(-m_0 \cos \theta)}{1 - \left\{ 1 - \frac{m_0}{1 + (m_1)^{-1} \times m_0^{m_2}} \right\} \exp(-m_0)} \times \frac{1}{\cos \theta}$$

General Formula (1)

is 10 or less,

when obtaining it from the value of secondary electron emission coefficient measured under the conditions that incident energy is 1 keV and incident angle is 0 degree as well as the values measured under the conditions that incident energy is 1 keV and incident angles θ are 20, 40, 60 and 80 degrees by conducting a regression analysis by the least square method in said general formula (1), provided that the second electron emission coefficient of its surface has two incident energies which satisfy the second electron emission coefficient $\delta = 1$ under the vertical incident conditions, and that when the larger energy of said two energies satisfying said condition $\delta = 1$ is referred to as a second cross-point energy, the secondary electron emission coefficients for the primary electrons whose incident angles are θ and 0 degrees are represented by

δ_{θ} , δ_0 , respectively, and

m_1 , m_2 have the values

$$m_1 = 0.68273$$

$$m_2 = 0.86212, \text{ respectively,}$$

in the incident energy equal to or lower than the second cross-point energy.

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28. The spacer according to claim 27, wherein the incident angle multiplication coefficient of secondary electron emission coefficient m_0 on the surface of said first member (on its surface) is 5 or less in the
10 incident energy equal to or lower than said cross-point energy when obtaining it from the value of secondary electron emission coefficient measured under the conditions that incident energy is 1 keV and incident angle is 0 degree as well as the values measured under
15 the conditions that incident energy is 1 keV and incident angles θ are 20, 40, 60 and 80 degrees by conducting a regression analysis by the least square method in said general formula (1).

20 29. The spacer according to claim 27 or claim 28, wherein said first member is provided with an uneven geometry at least on a part of its surface.

(The spacer according to claim 27 or claim 28, comprising an uneven geometry at least on a part of its
25 surface.)

30. The spacer according to claim 27, comprising

a substrate provided with an uneven geometry at least
on a part of its surface and a film coating said uneven
geometry portion, the thickness of said film being
smaller than the height difference between the top and
5 lowest portions of the uneven geometry of said
substrate.

31. The spacer according to claim 27, comprising
an uneven geometry at least on a part of its surface,
10 said uneven geometry being formed in all directions
parallel to said surface.

32. The spacer according to claim 27, comprising
an uneven geometry at least on a part of its surface,
15 said uneven geometry having the average cycle of 100 μm
or shorter.

33. The spacer according to claim 27, comprising
an uneven geometry at least on a part of its surface,
20 said uneven geometry having the average cycle of 10 μm
or shorter.

34. The spacer according to claim 27, comprising
an uneven geometry at least on a part of its surface,
25 said uneven geometry having the average roughness
ranging from 0.1 μm to 100 μm .

35. The spacer according to claim 27, comprising an uneven geometry at least on a part of its surface, said uneven geometry consisting of the cycles of at least two kinds of unevenness.

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36. The spacer according to claim 27, comprising an uneven geometry at least on a part of its surface, said uneven geometry being obtained by removing the material surface of said first member nonuniformly (by removing its material surface nonuniformly).

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37. The spacer according to claim 27, comprising a film at least on a part of its surface, said film having a sheet resistivity of $10^7 [\Omega/\square]$ to $10^{14} [\Omega/\square]$.

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38. The spacer according to claim 27, comprising a film at least on a part of its surface, said film containing at least one kind of metal, carbon, silicon, or germanium and consisting of nitride, oxide or carbide.

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39. The spacer according to claim 27, comprising a film at least on a part of its surface, said film, when being formed on a smooth substrate so as to have a smooth surface, having a composition which provides secondary electron emission coefficient of 3.5 or less under vertical incident conditions.

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40. The spacer according to claim 27, comprising a film at least on a part of its surface, the surface of said film having a high oxygen concentration as compared with the inside thereof.

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41. The spacer according to claim 27, comprising a film at least on a part of its surface, said film being formed by any one of the following methods: sputtering, vacuum deposition, wet printing, spraying,
10 or dipping.

42. The spacer according to claim 27, comprising a film on its surface, the foundation of said film comprising an uneven geometry, the thickness of said
15 film being smaller than the height difference between the top and lowest portions of the uneven geometry of said foundation.

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